STRATIGRAPHIC COMPLEXITY, SOURCE AND RESERVOIR POTENTIAL OF THE NIOBRARA FORMATION IN THE ROCKY MOUNTAIN REGION: A REGIONAL SYNTHESIS

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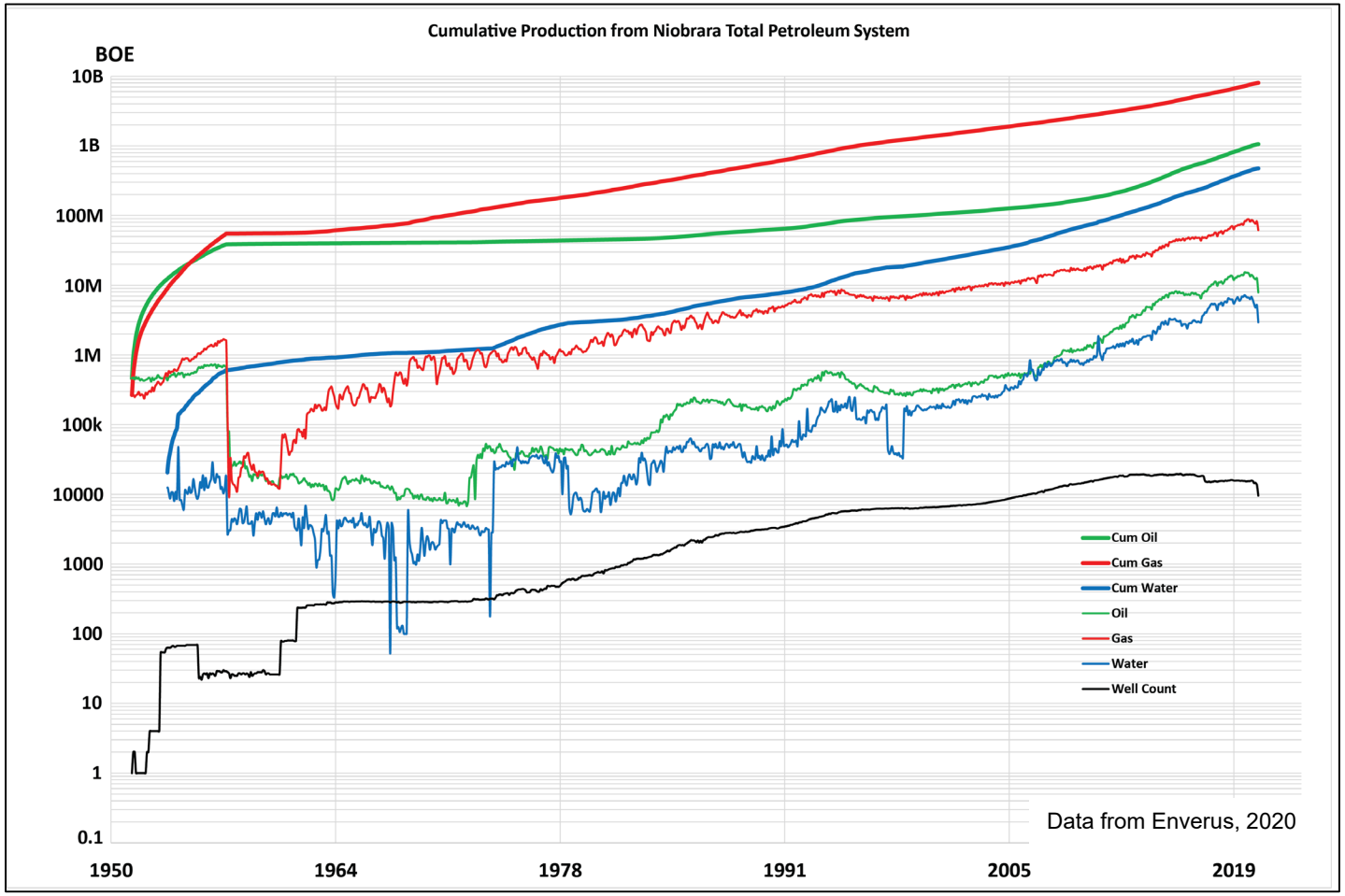
Outline

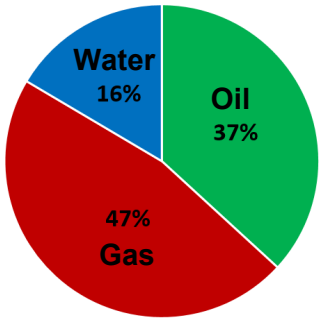
- Introduction
- Research Questions
- Cretaceous Time Period
- Lithostratigraphy
- Sequence Stratigraphy
- Chemostratigraphy
- Source Rock Potential
- Preliminary Observations
- Future Work

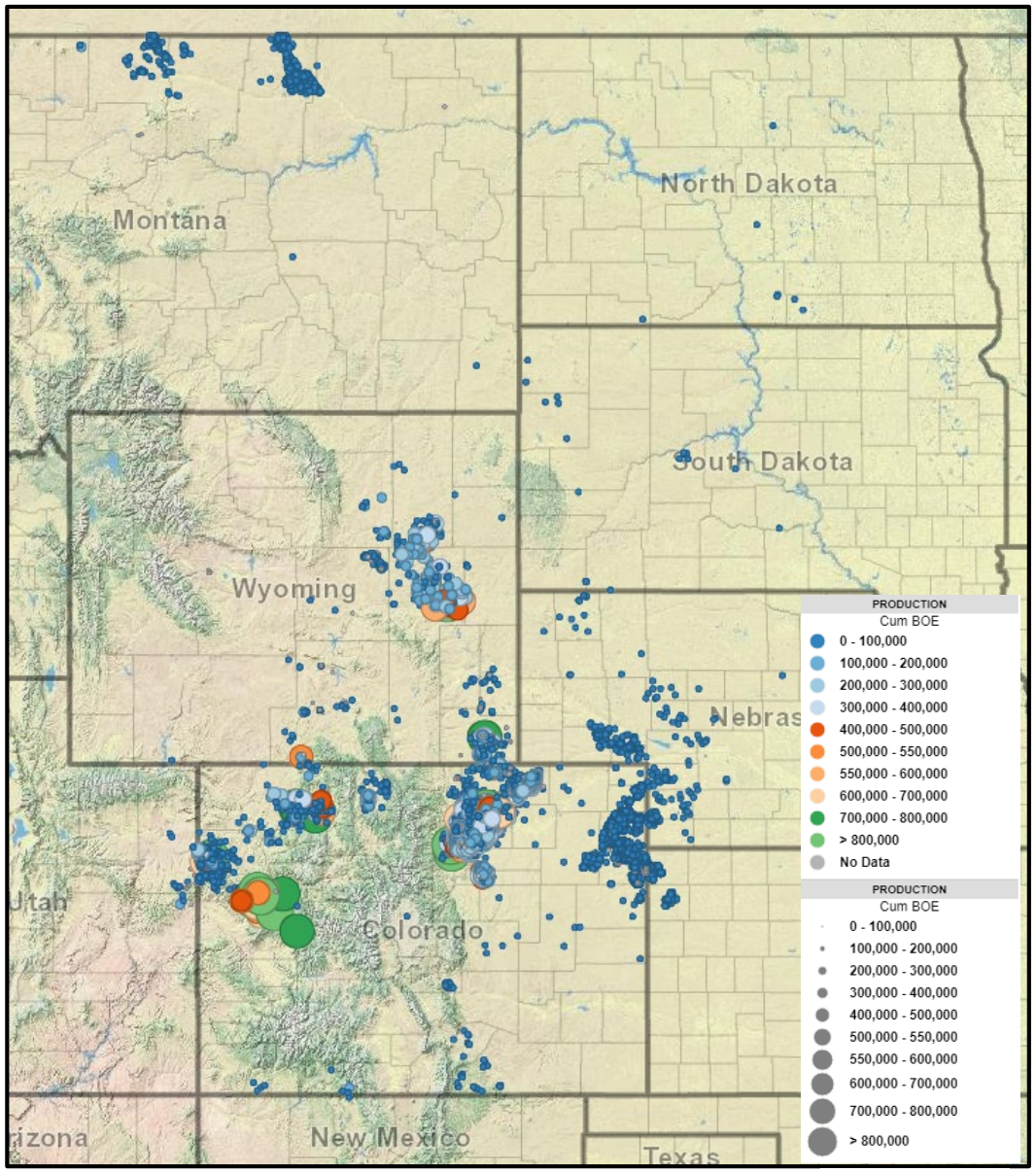
Introduction



Production exceeding **1 BBO** and **8 TCF**

- Favorable lithology
- Thickness
- Geomechanical properties
- Sufficient reservoir pressure





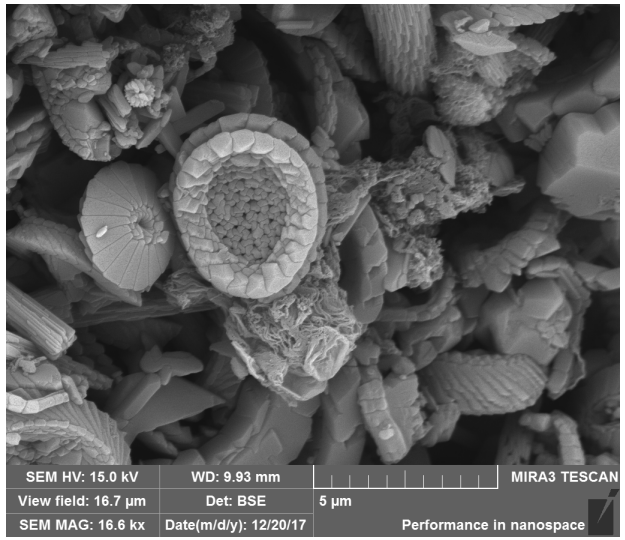
Enverus, 2020

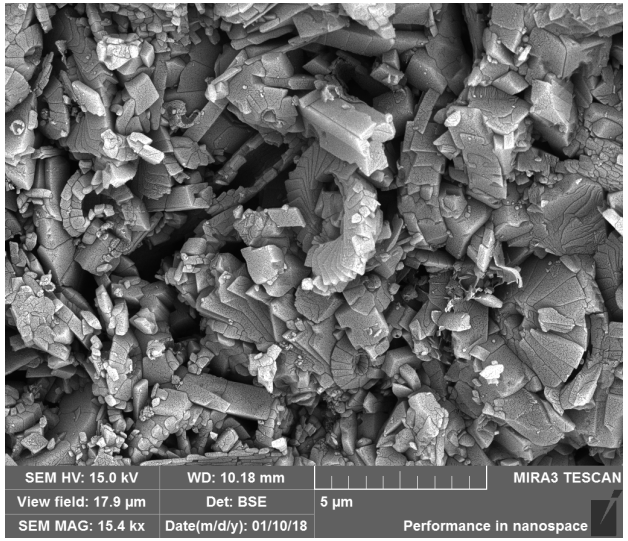
Objectives of the Study

Provide a high-resolution stratigraphic framework for the Niobrara Formation to study the nature of siliciclastic and carbonate deposition, and geologic controls on source and reservoir potential in the WIS

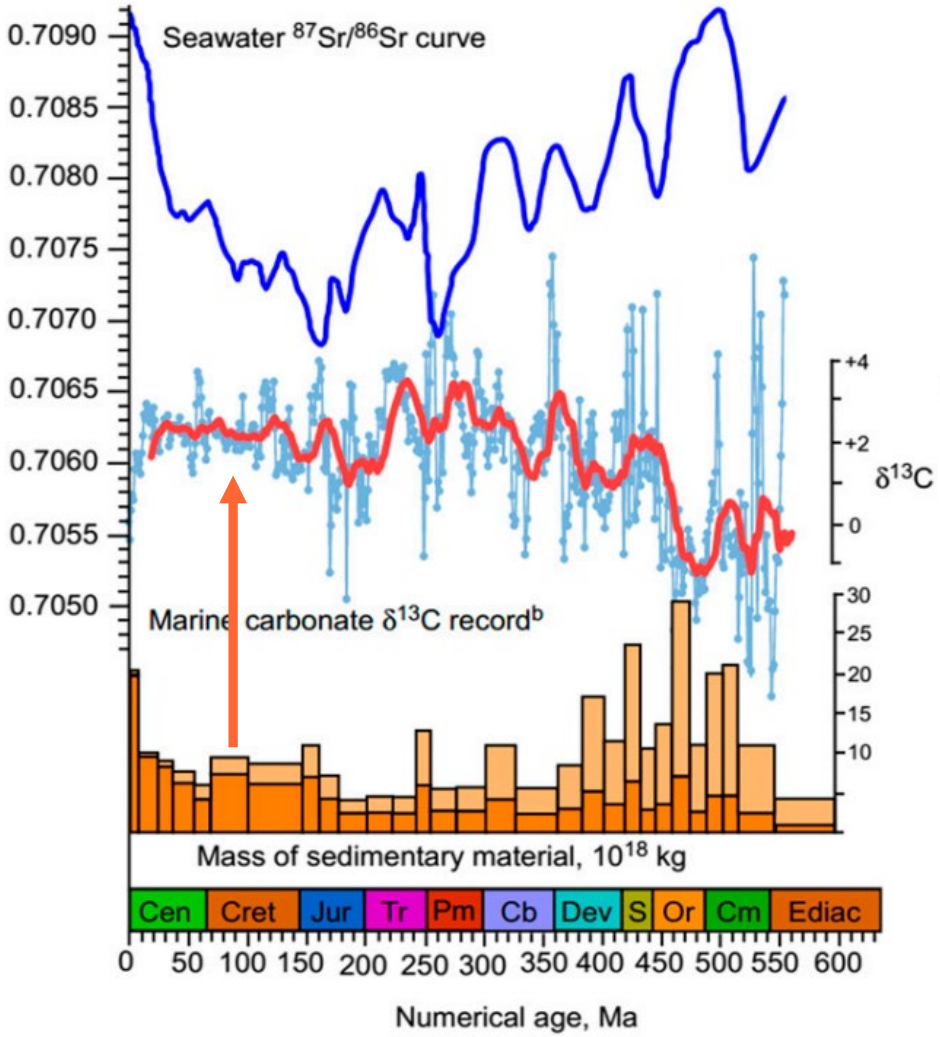
- Changes in stratigraphic nature in the WIS
- Controls on siliciclastic and chalk/carbonate deposition
- Geochemical investigation using elemental data and stable isotopes
- Biostratigraphy, volcanic ash and bentonite dating for geochronology
- Source rock potential
- An approach to delineate the distribution of geomechanical properties
- Relationship of geomechanics and reservoir quality
- WIS wide understanding of the Niobrara Formation

Paleoclimatology and Carbon Balance

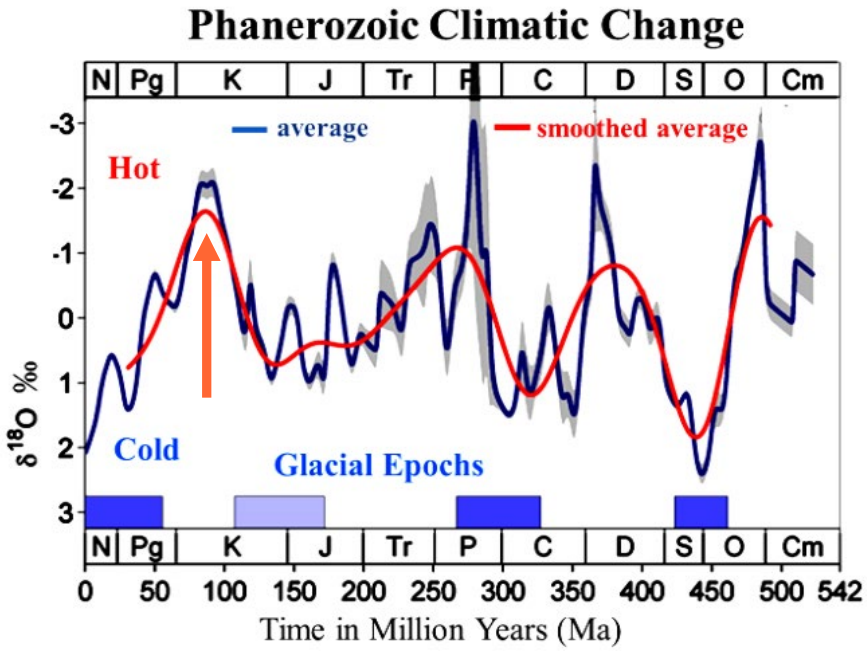




Lopez, 2018



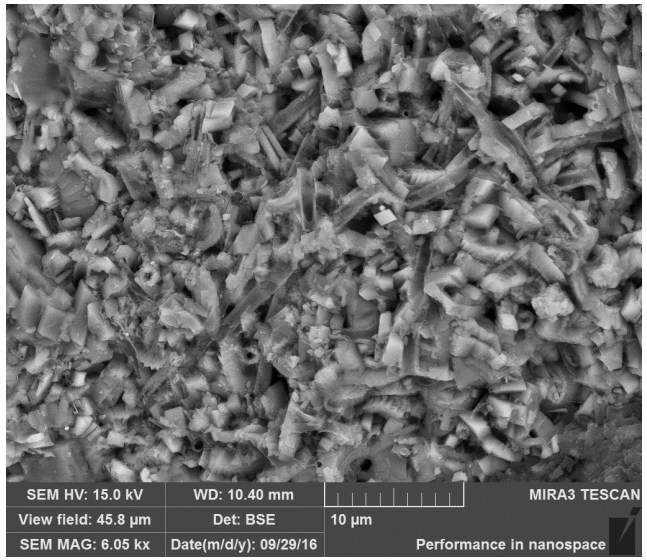
Veizer et al, 1998

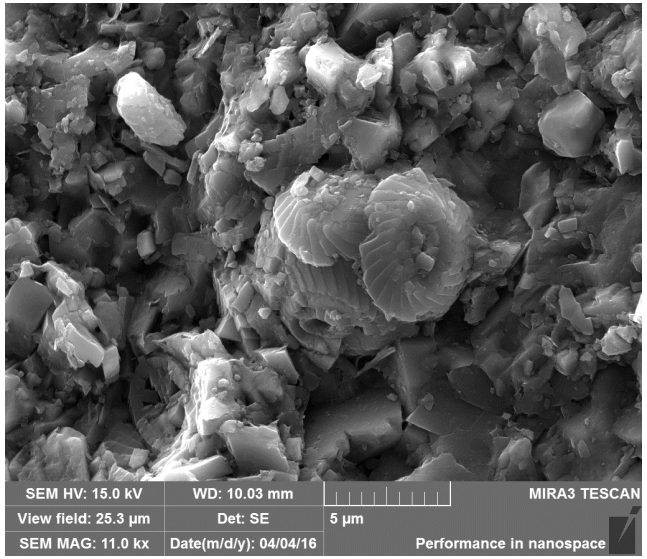


Shields et al, 2017

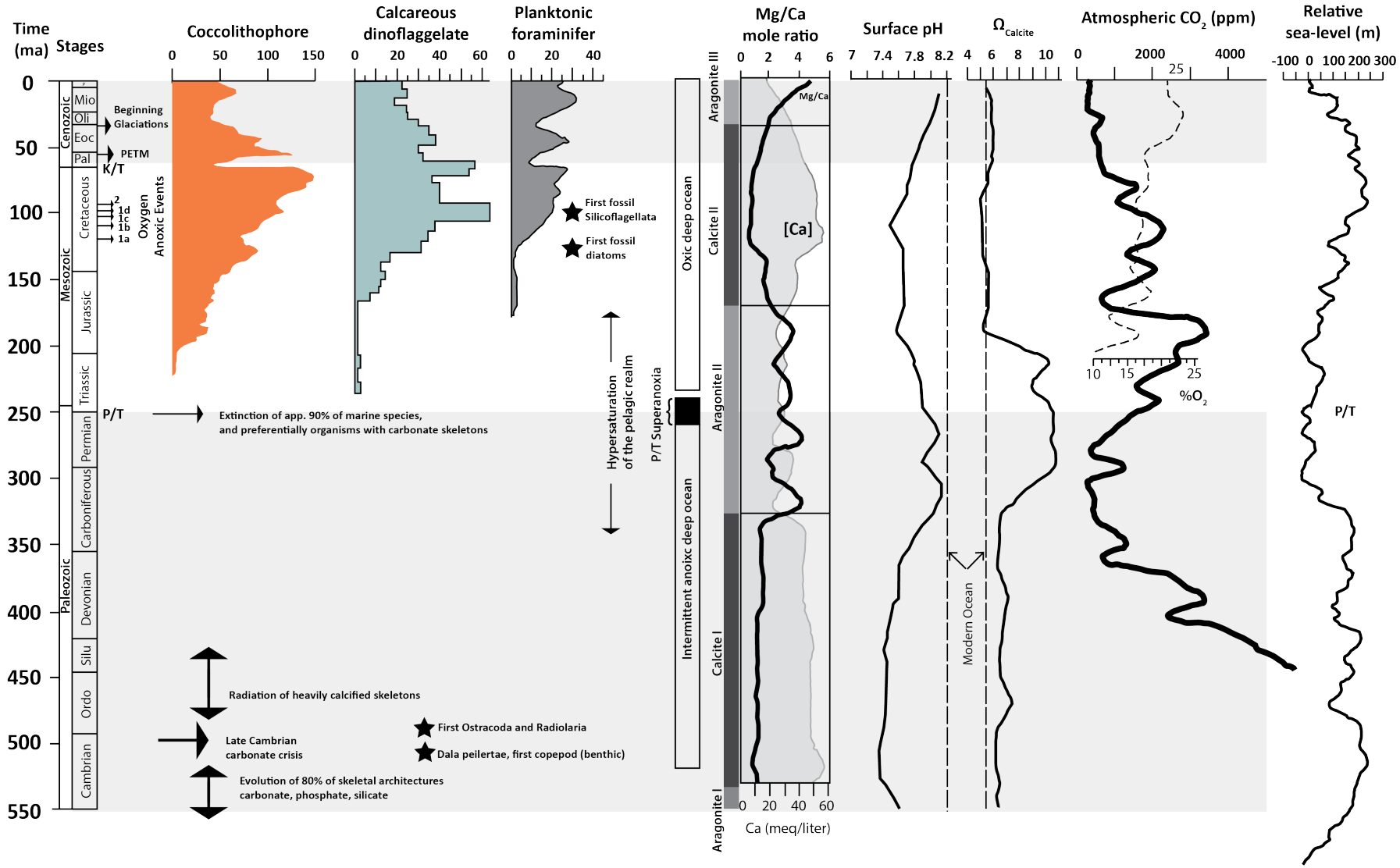
- First appearance of flowering plants
- Diversification of insects
- Radiation of diatoms
- Most abundant zooplanktons
- Record contribution to biomass

Evolution of Coccolithophores



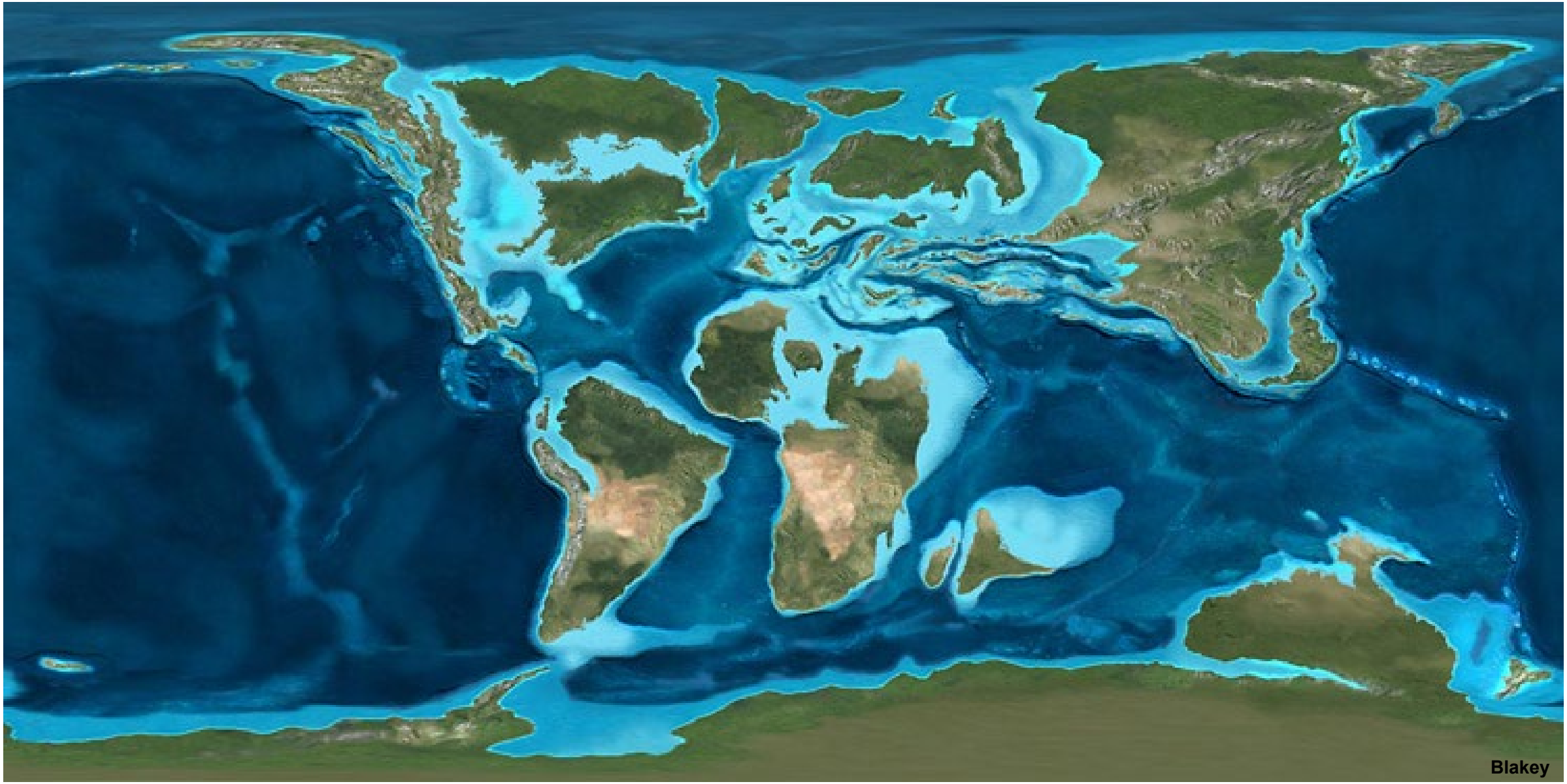


Aydin, 2017



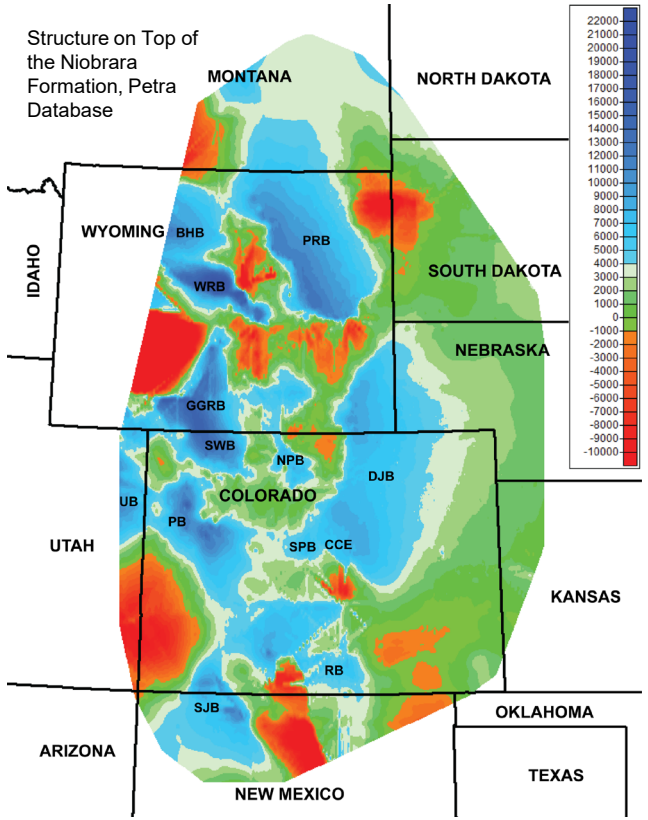
Modified from De Vargas, 2007

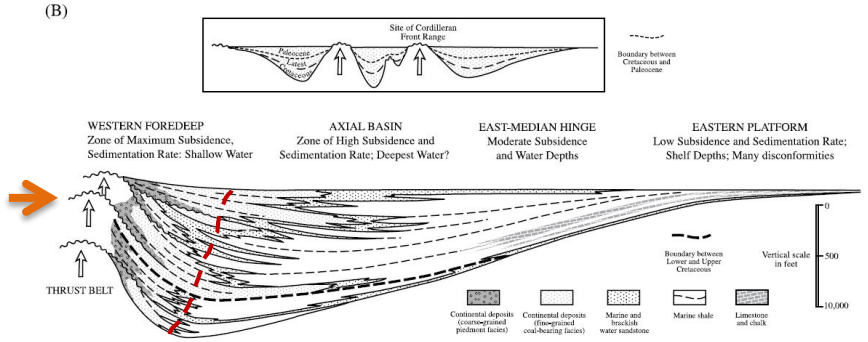
Chalk Deposition



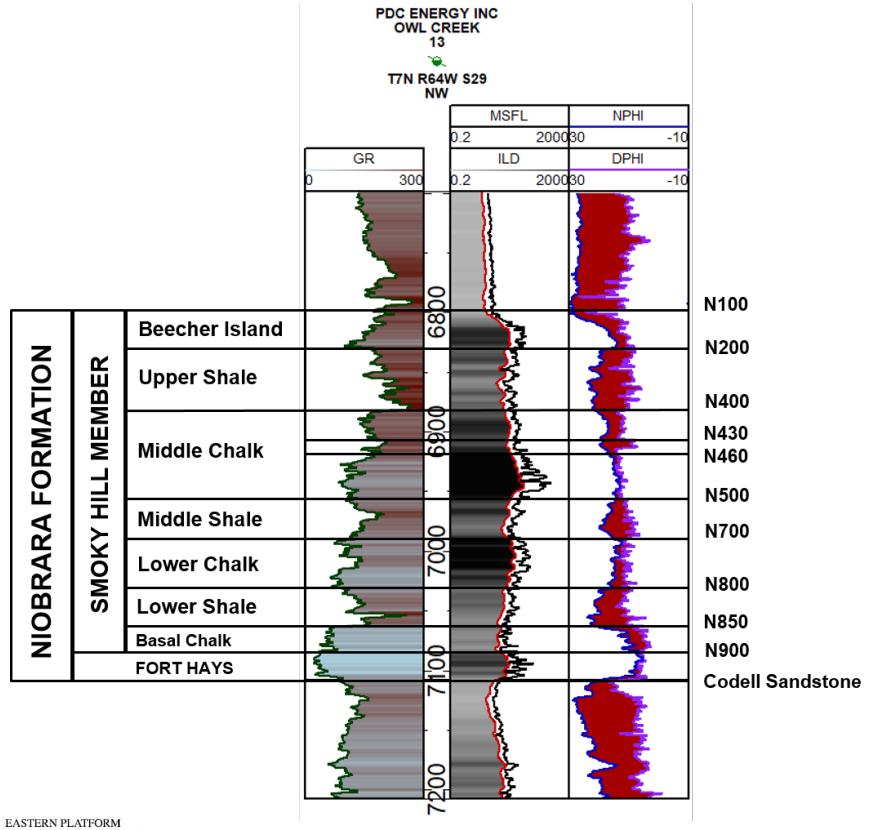
Study Area

Modified from Blakey, 2014





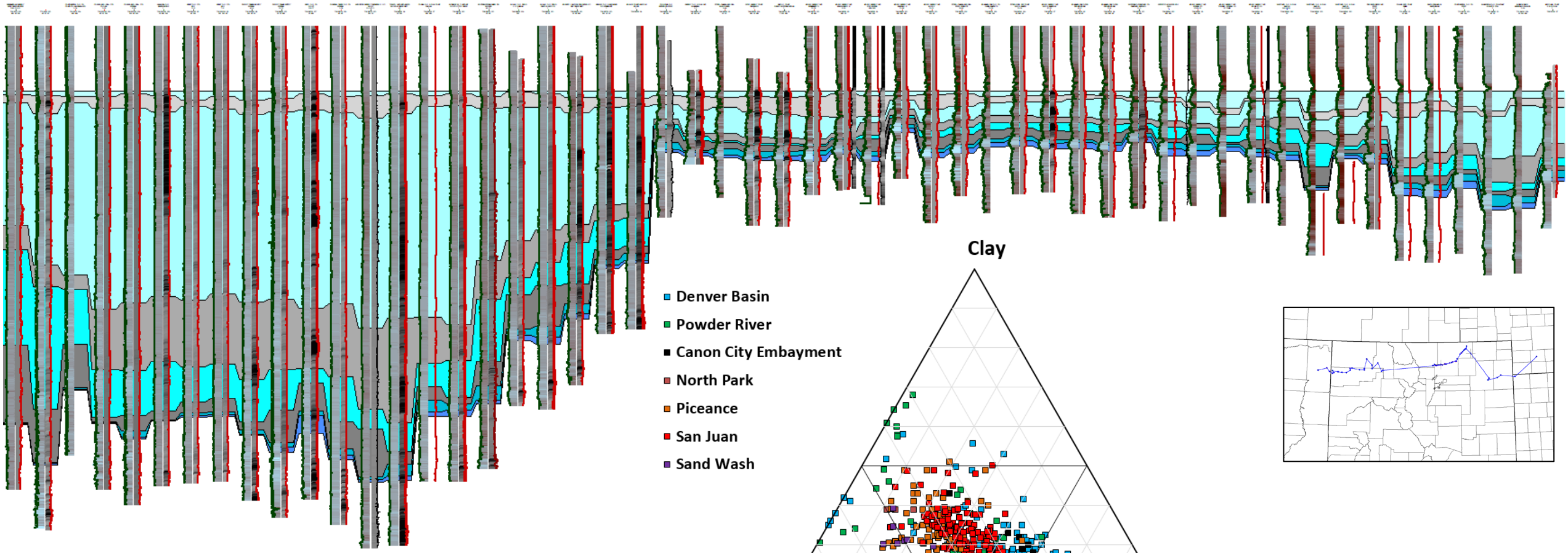
Tectonic zones of the Rocky Mountain Region (Martinsen, 2003, after Kauffman, 1977).



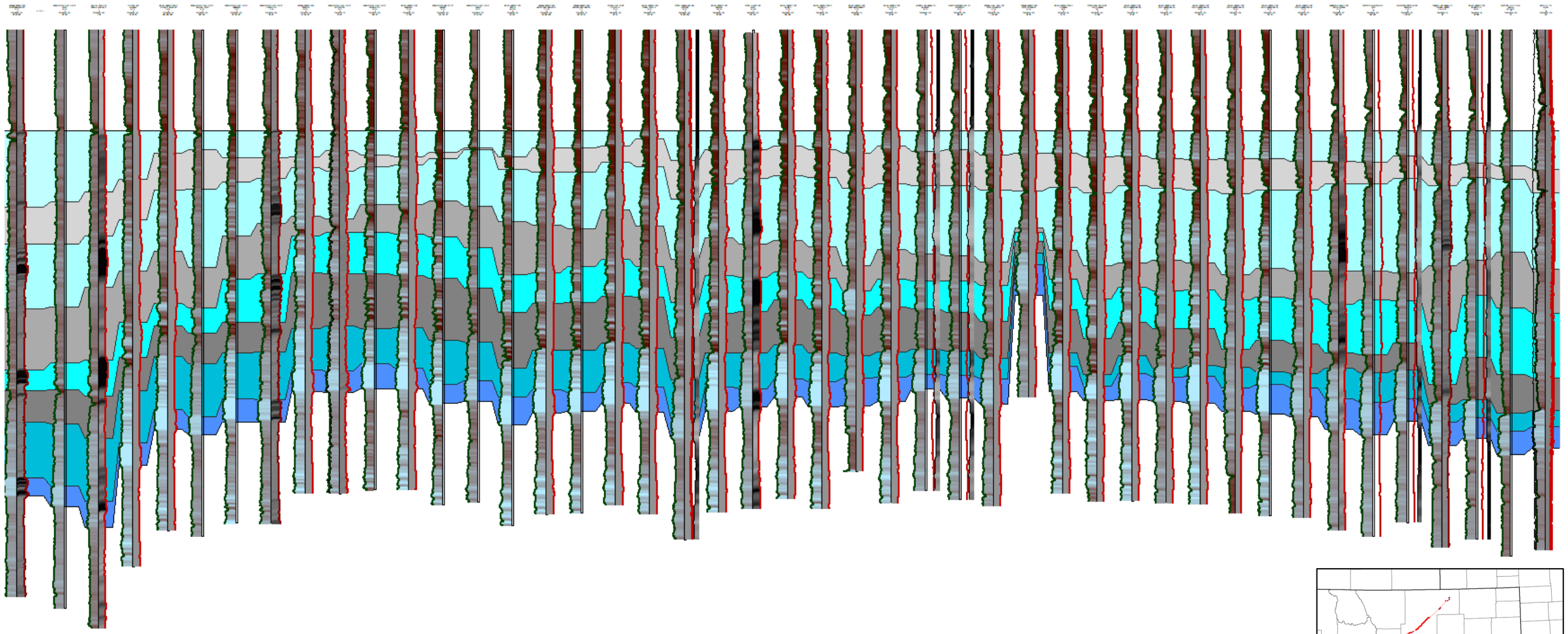
Modified from Longman et al., 1998

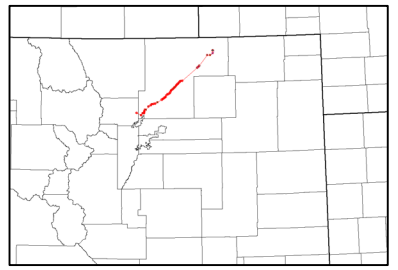
Niobrara Formation

Uinta | Piceance | Sand Wash | North Park | Denver Basin

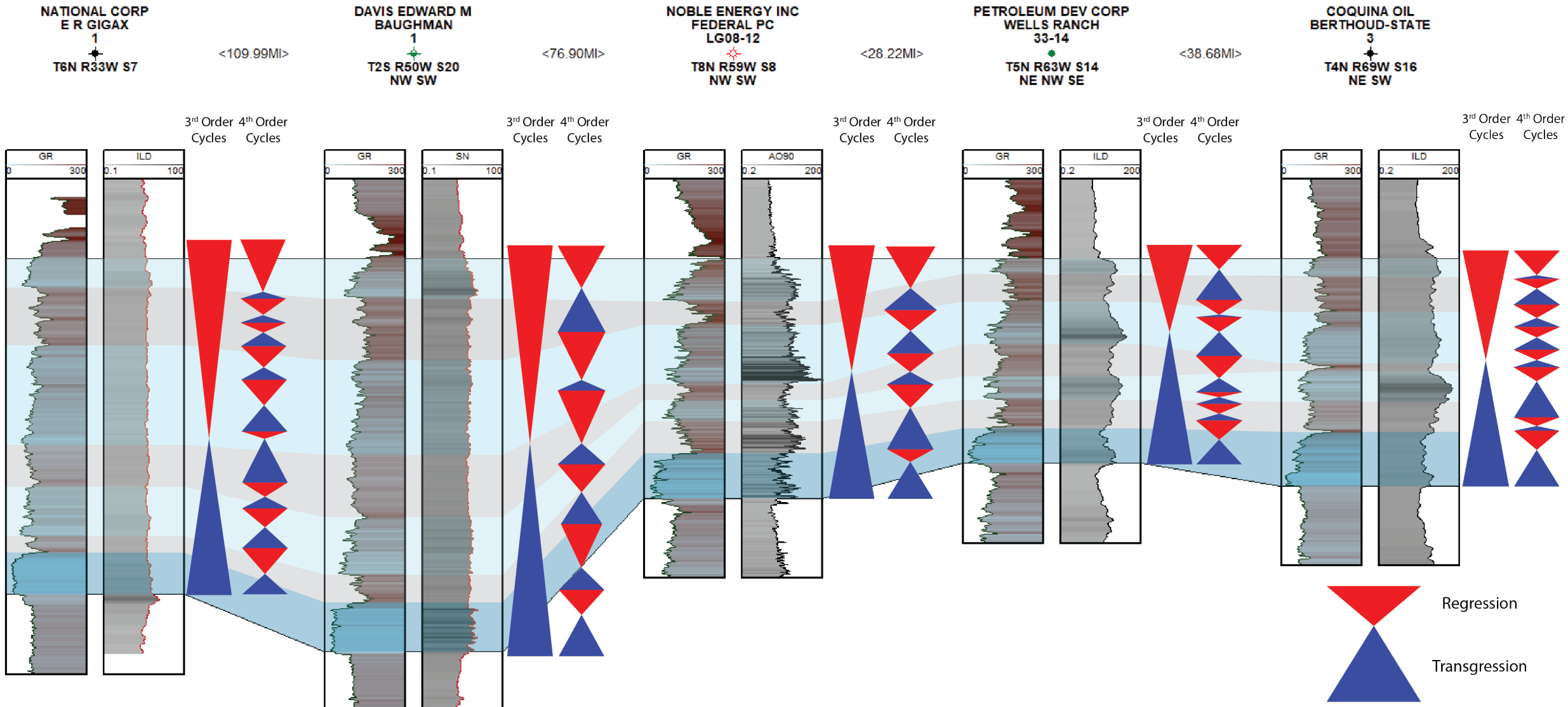


Lithostratigraphy

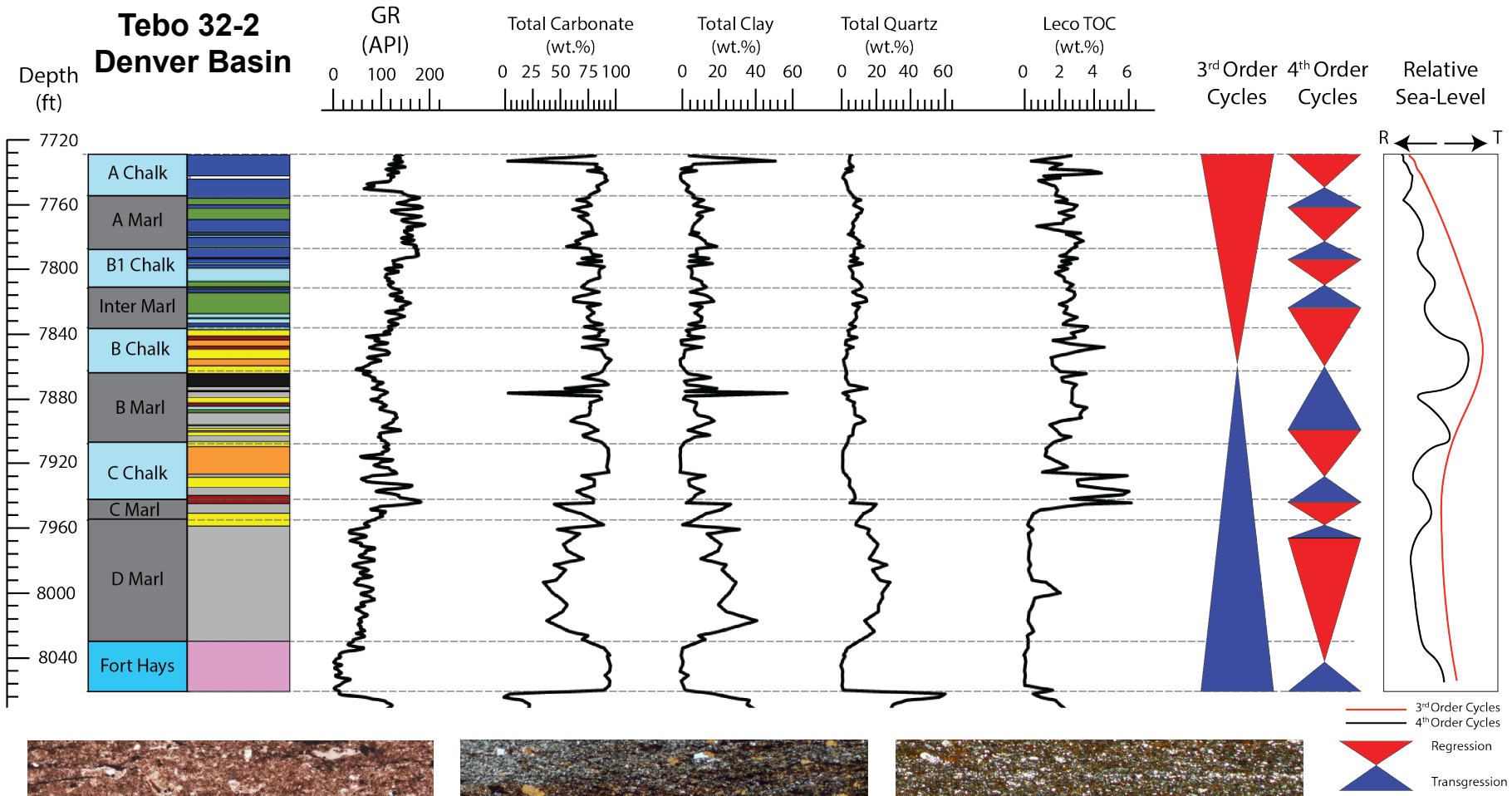


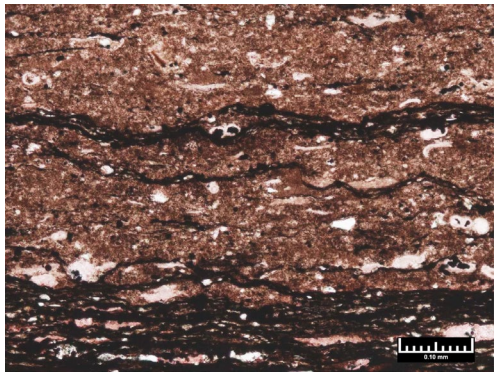


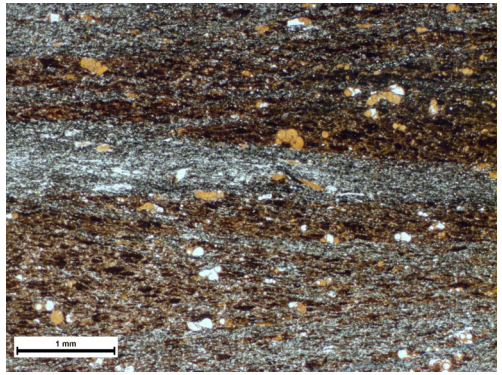
Sequence Stratigraphy

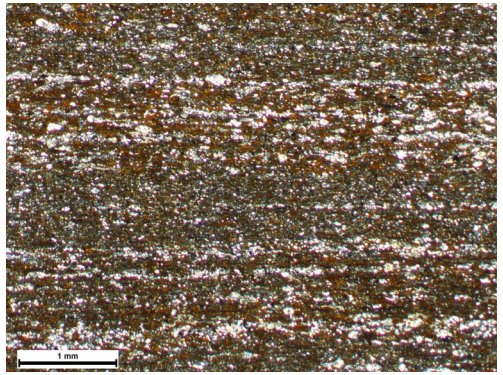


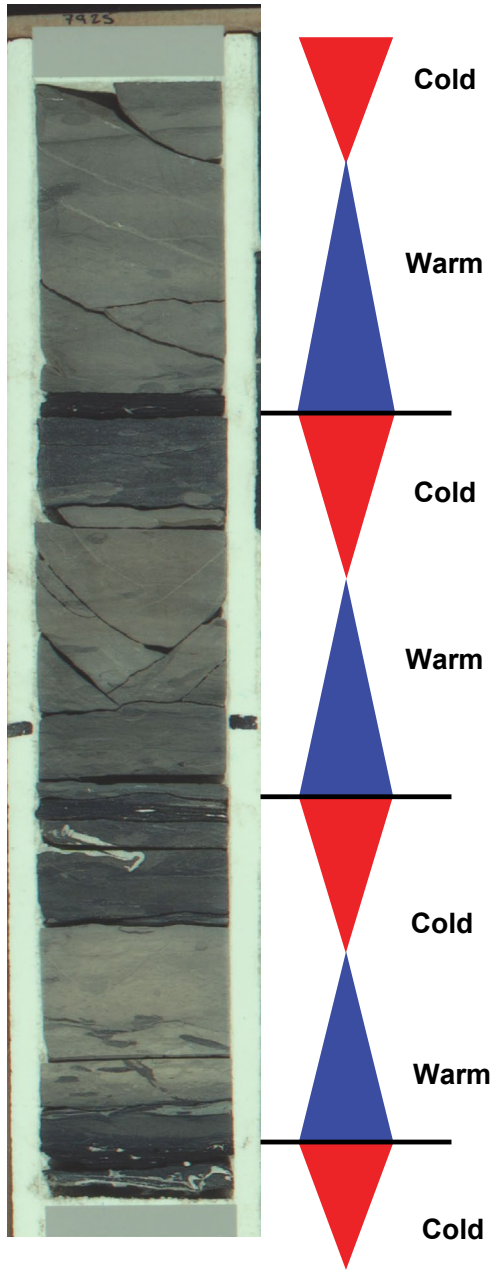
Sequence Stratigraphy



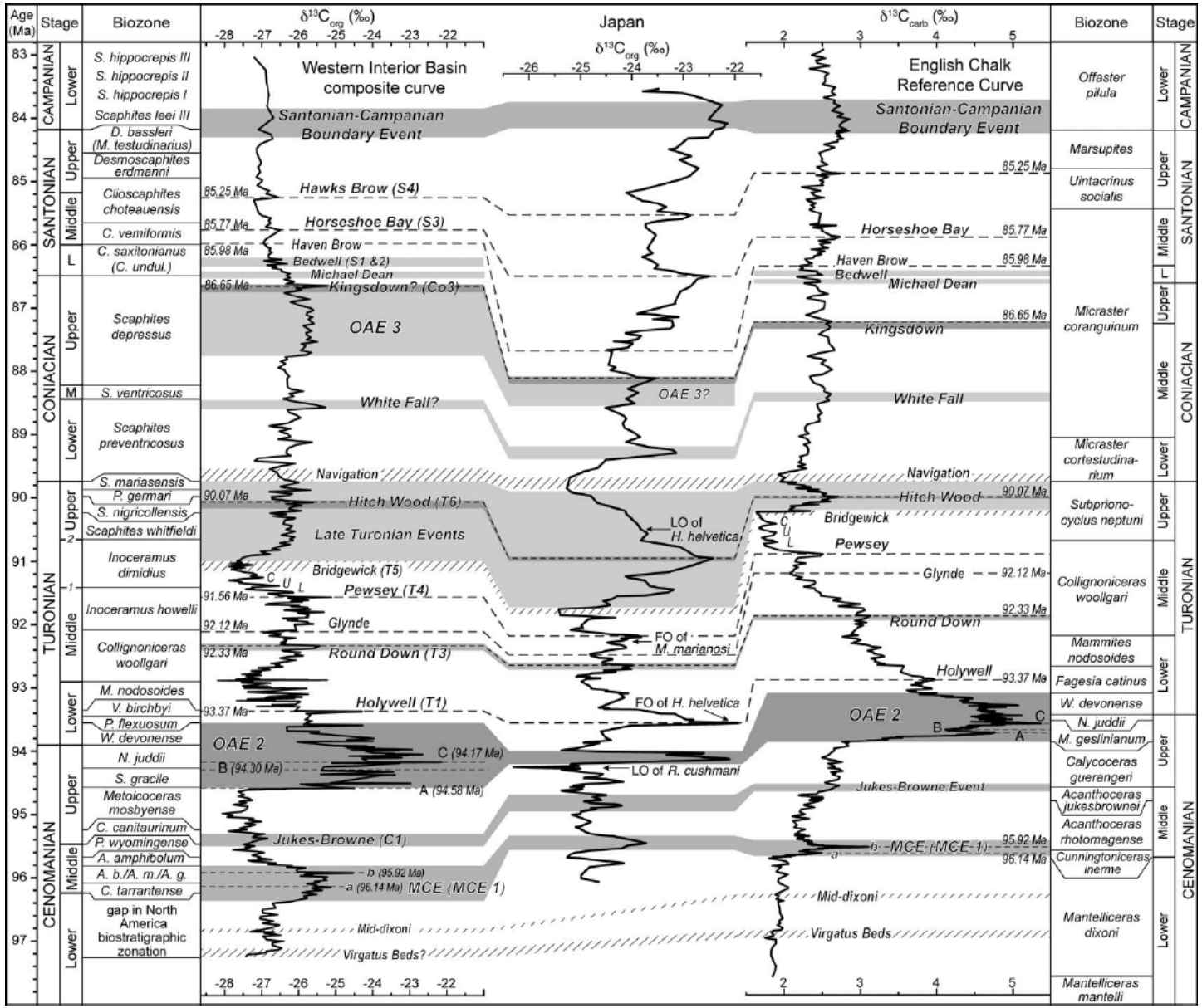






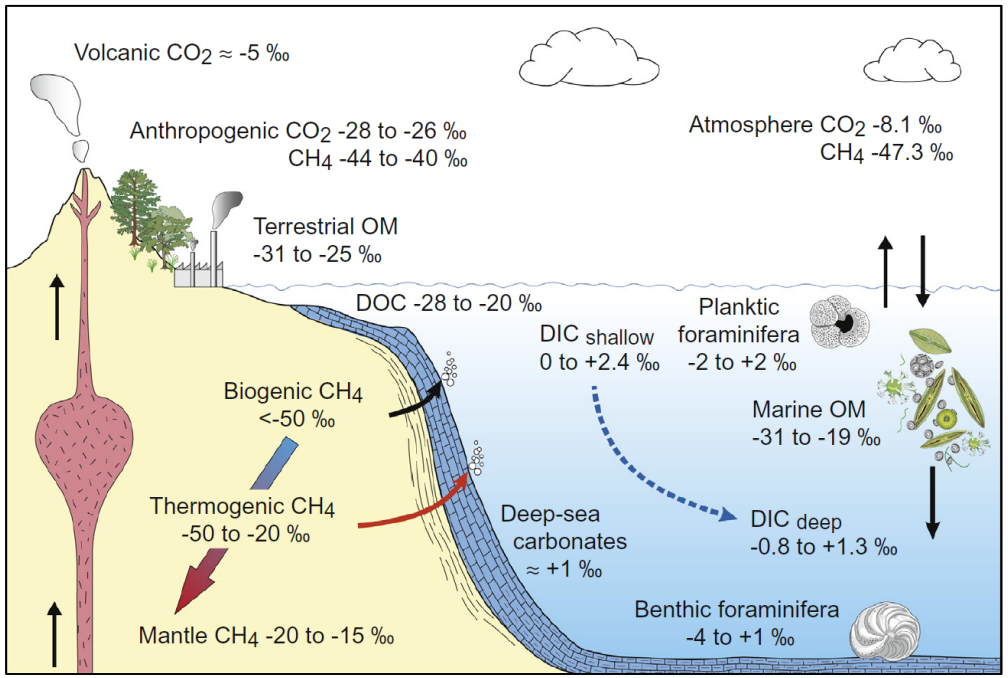


Chemostratigraphy



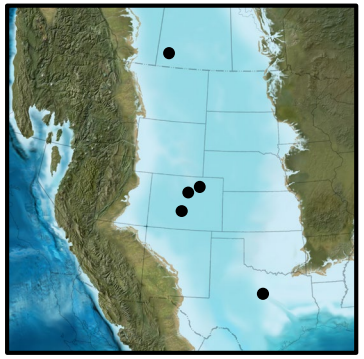
(Joo and Sageman, 2014)

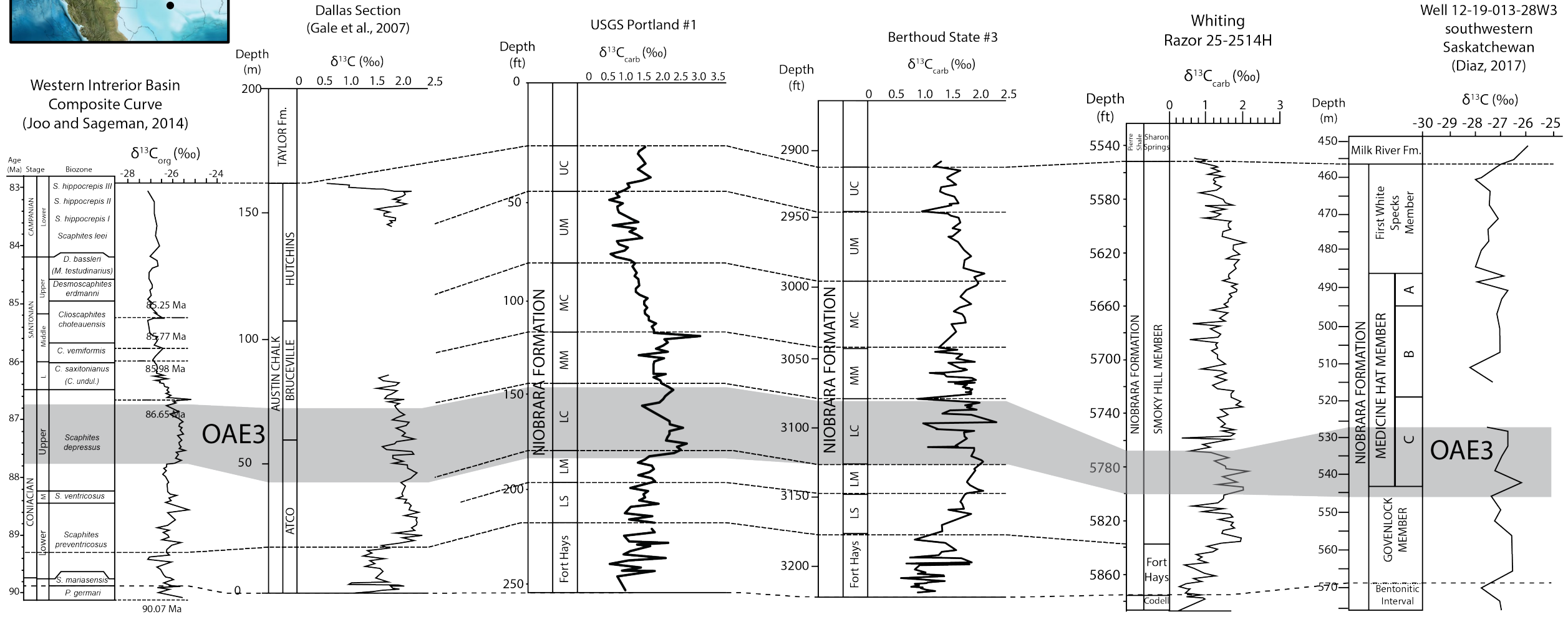
- Stable isotopes can be correlated across continents
- Useful for understanding changes in carbon balance
- Increasing δ13C values indicate increased productivity
- Niobrara Formation involves OAE 3



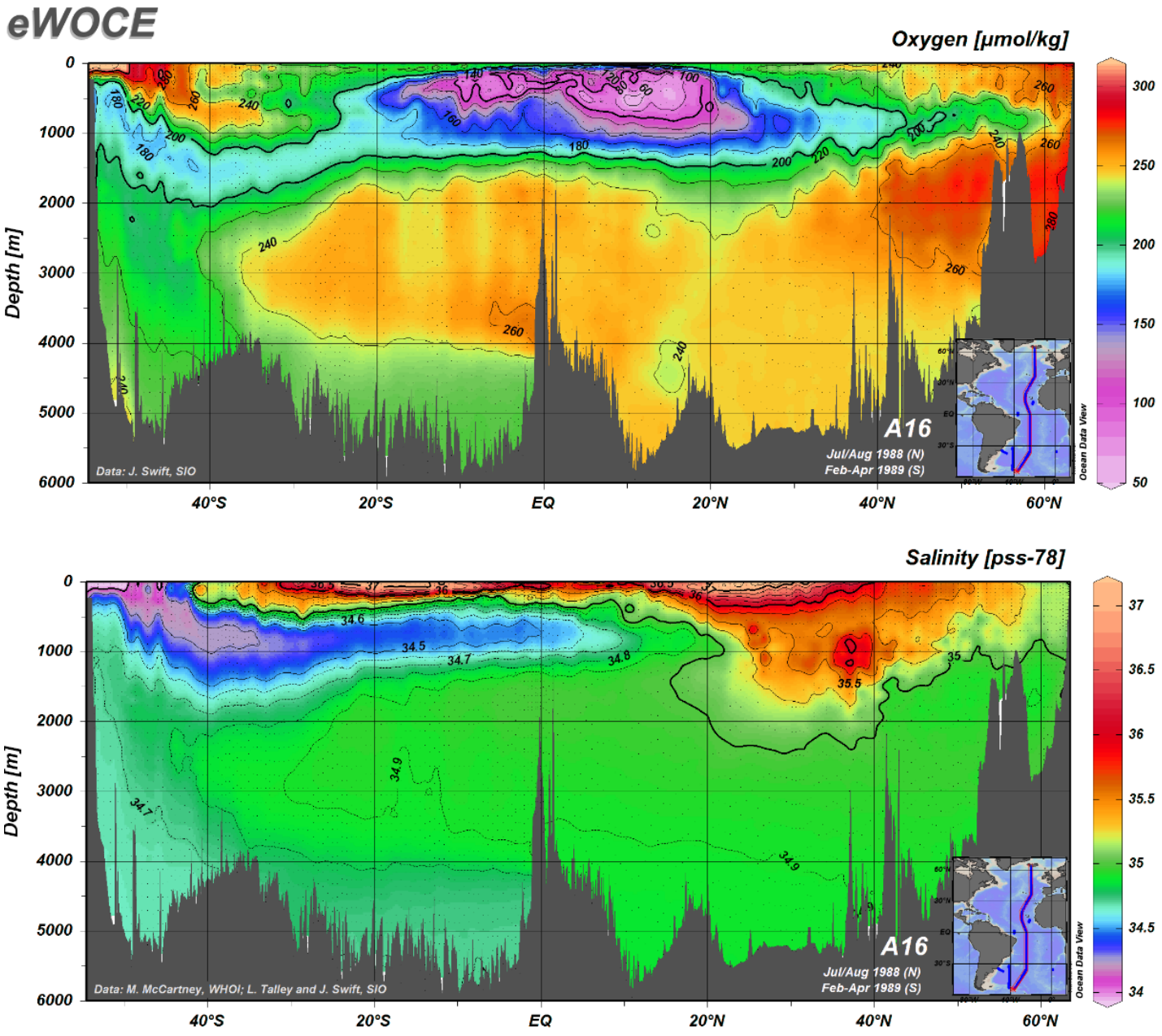
(Mackensen and Schmiedl, 2019)

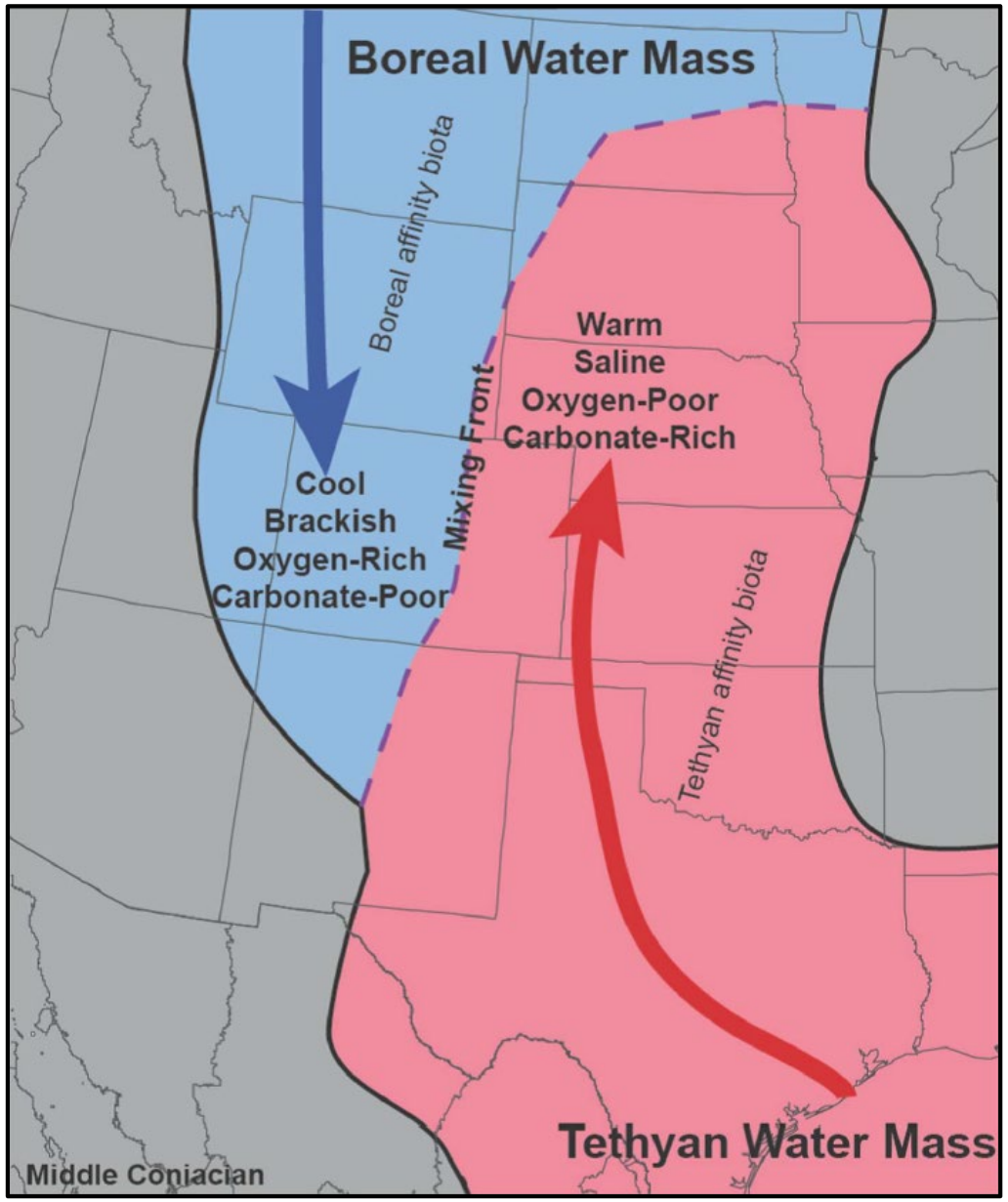
Chemostratigraphy





Ocean Mixing

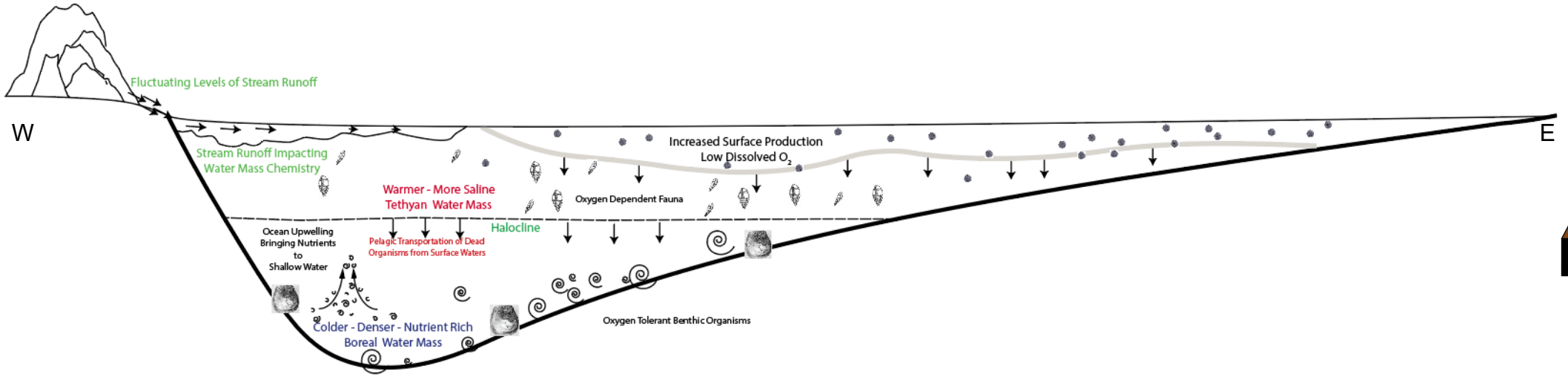


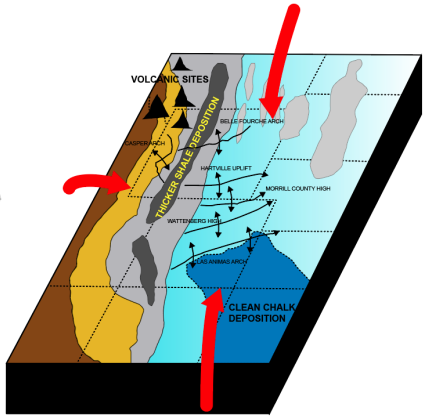


Lowery et al. 2018

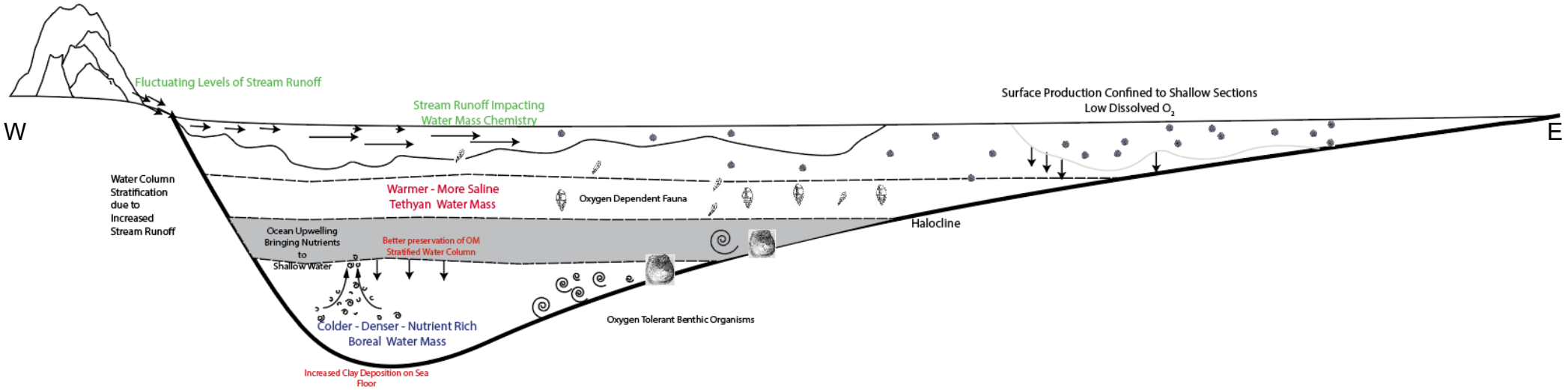
Climatic Influence on WIS

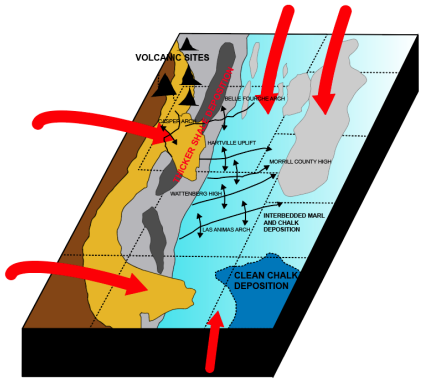
Warm and Dry Climate





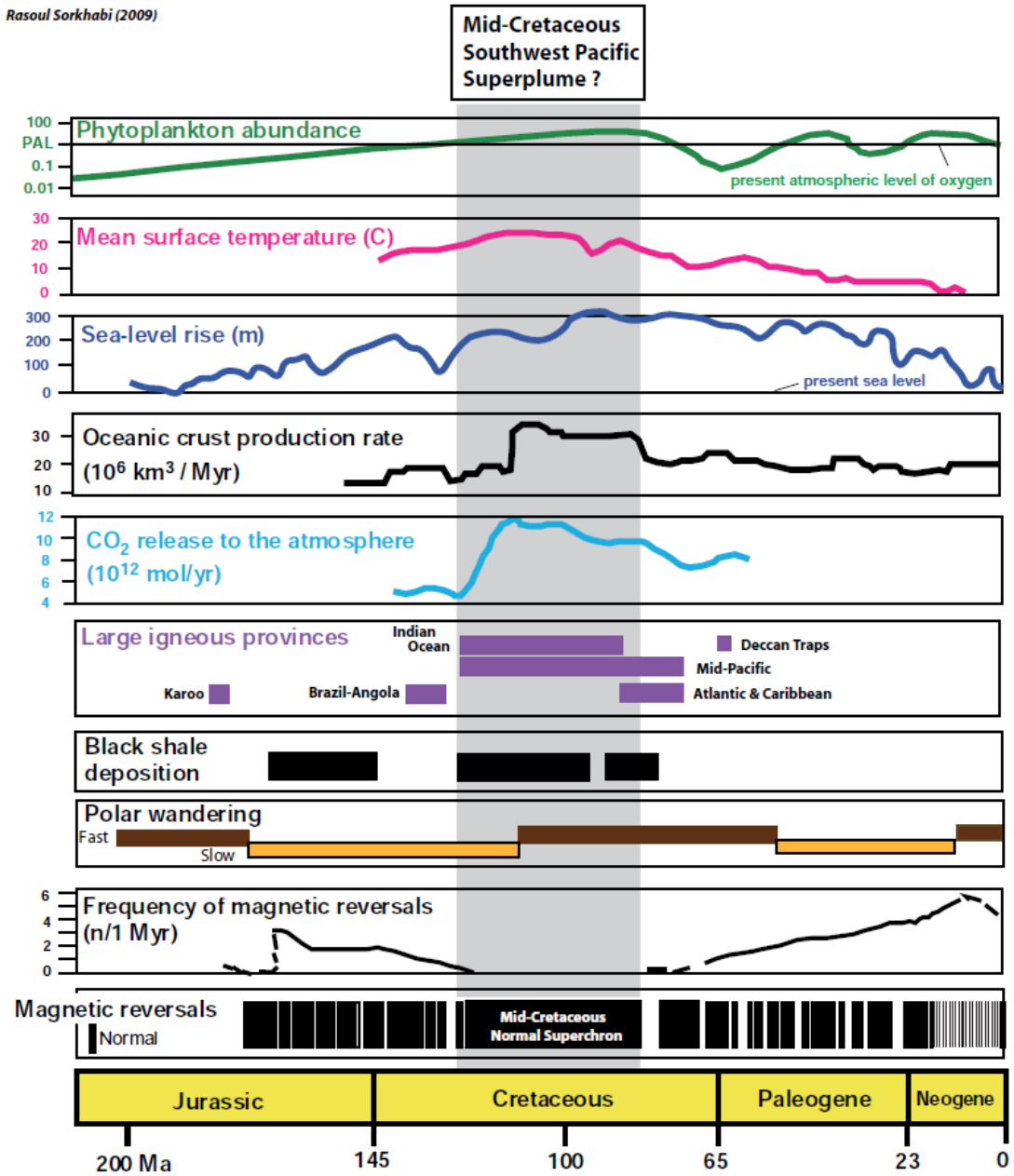
Cold and Wet Climate

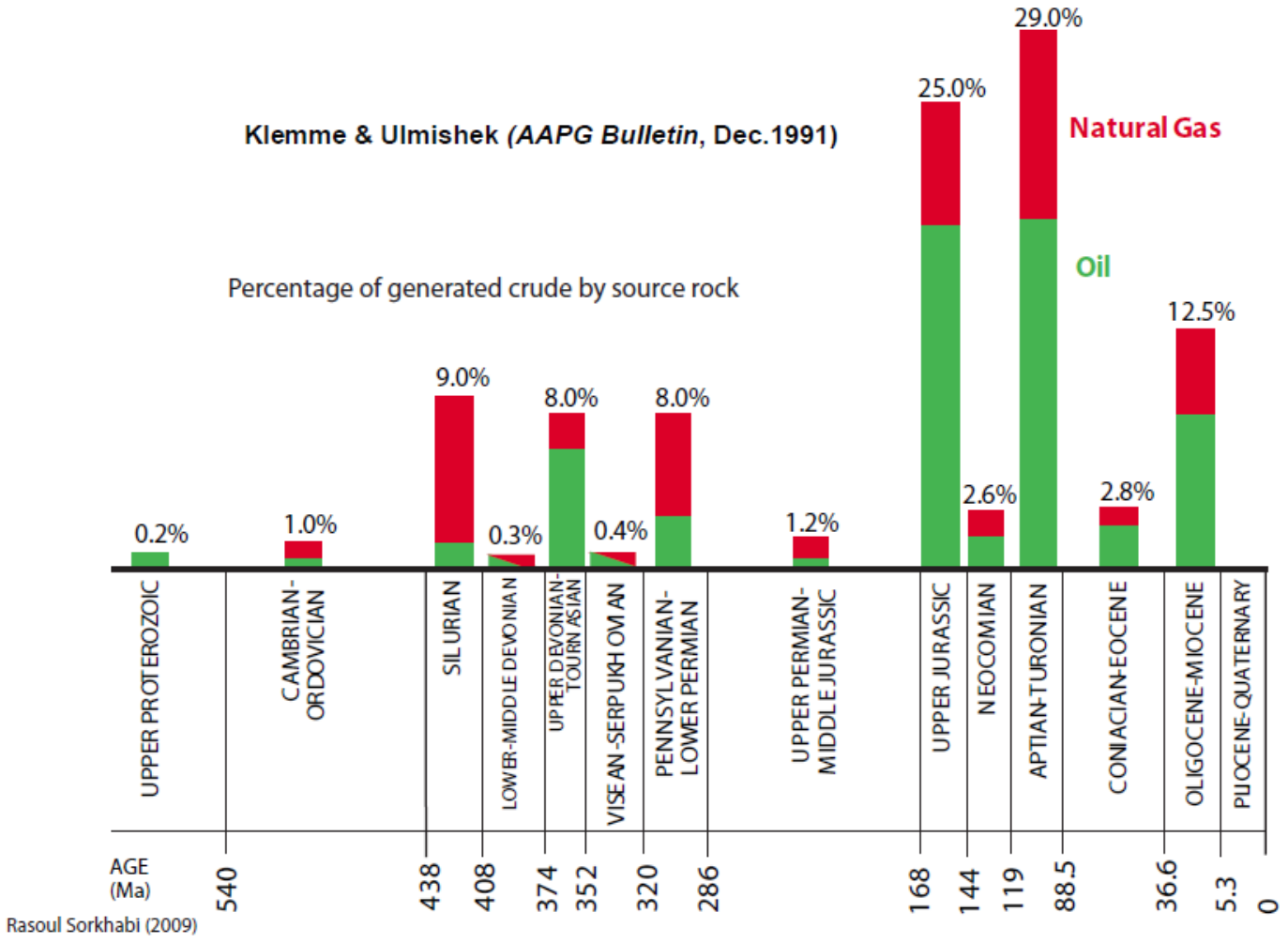




Block diagrams modified from Longman et al., 1998

Cretaceous Time Period



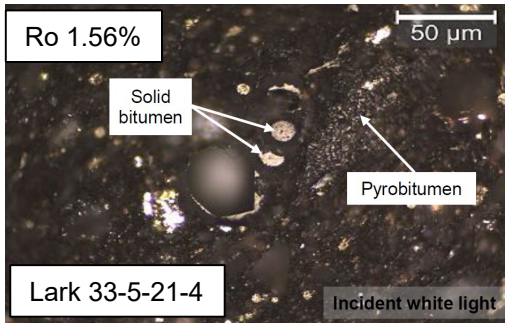


Rasoul Sorkhabi (2009)

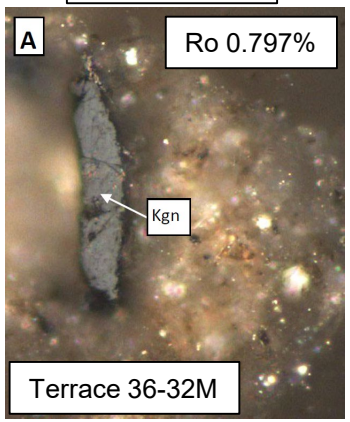
Source Rock Potential

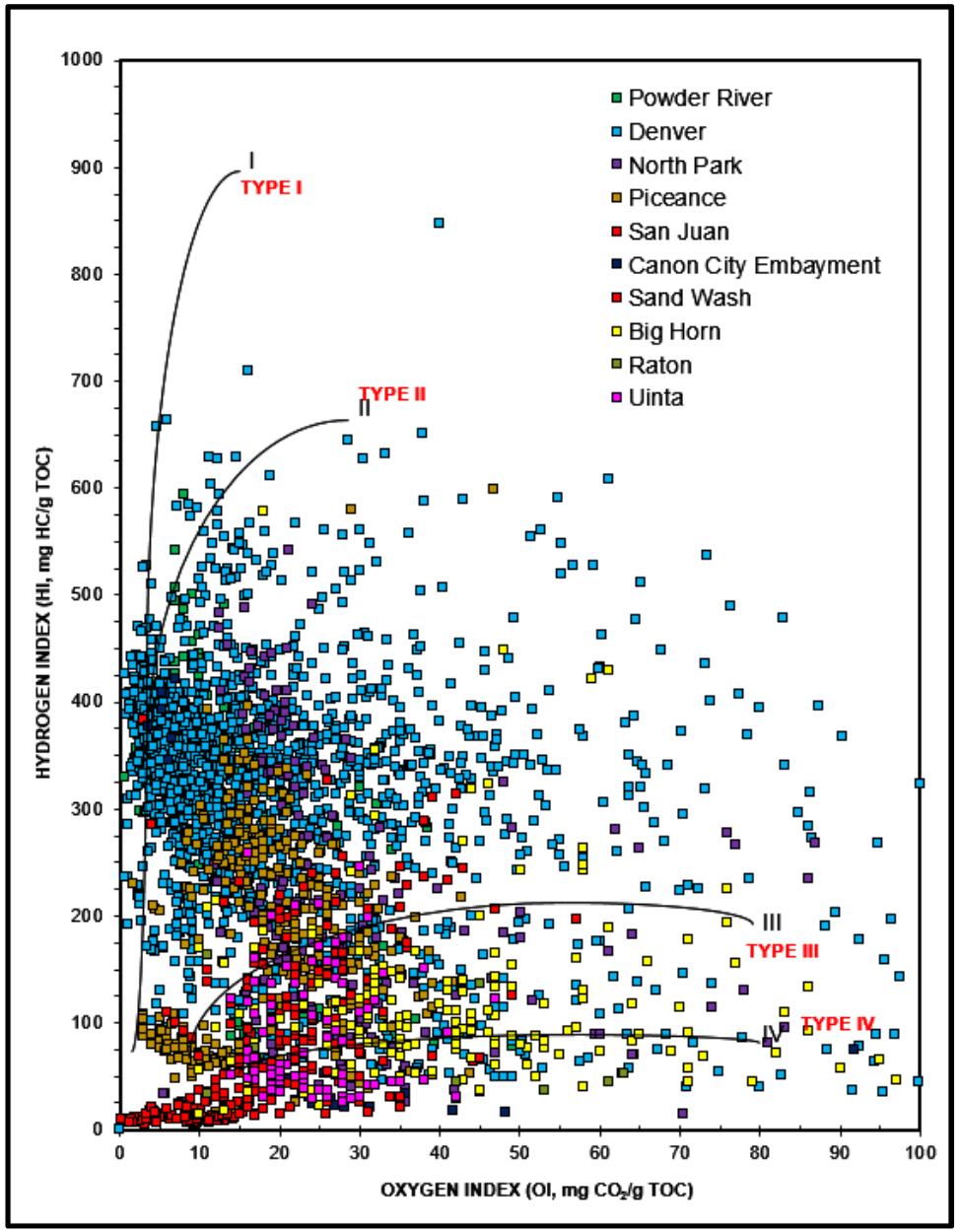
- Kerogen type II to II/III
- Depends on the location in WIS
- Close proximity to Sevier Highlands result in more woody material
- Oil and gas production

San Juan Basin



Denver Basin

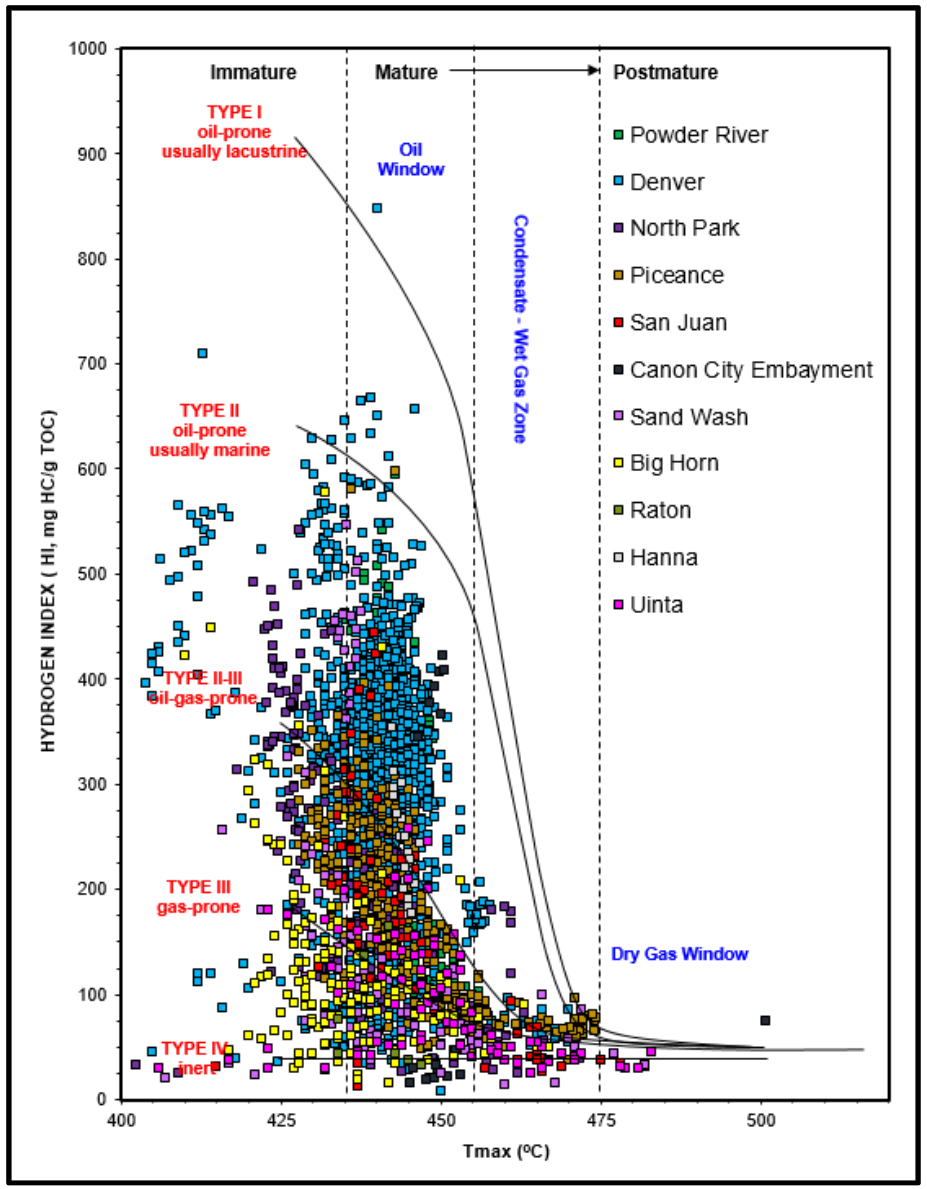




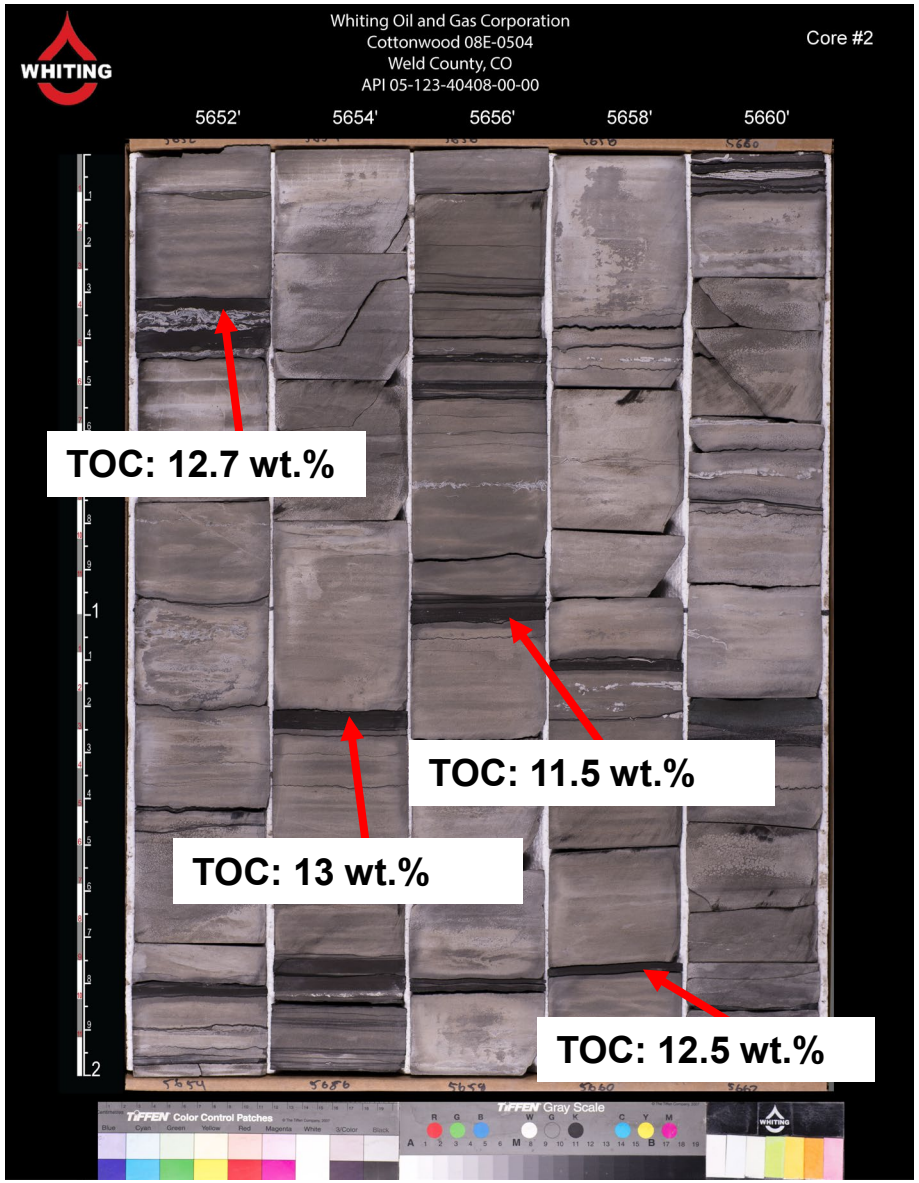
Data compiled from past studies, USGS, and the literature

Blakey

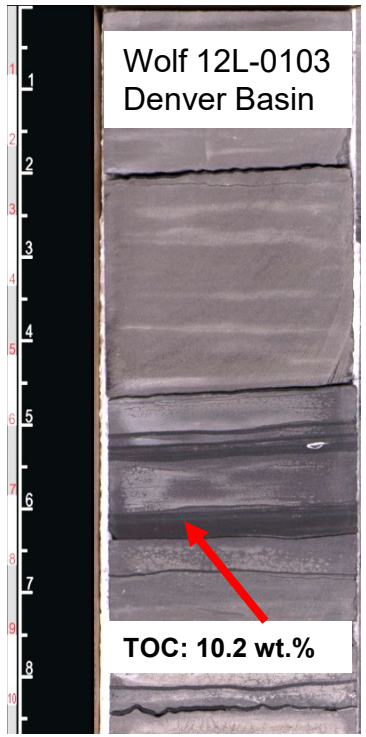
Source Rock Potential



Data compiled from past studies, USGS, and the literature



- High organic content
- Above 10 wt.%
- Wet vs. dry climates? High organic productivity in stratified water columns
- OM is preserved
- Decreased oxygen content



Preliminary Observations

- Lithology and mineralogy change across the basin
- Cyclic nature can be traced on well-logs
- Chalk-marl laminae display microscopic alternations
- OAE 3 within the Niobrara Formation
- Climatic influence on deposition is strong
- Kerogen type is II to II/III
- Maturity varies based on burial depth and location in WIS
- TOC can be more than 10 wt.%

Future Work

- Increase data resolution for chemostratigraphy
- Identify biostratigraphic units
- Perform ash bed/bentonite radiometric age dating
- Investigate the applicability of mechanical stratigraphy
- Understand how rock strength relates to reservoir performance

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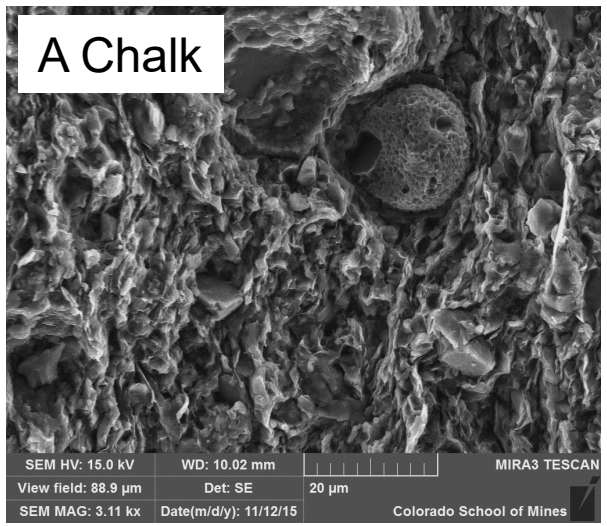
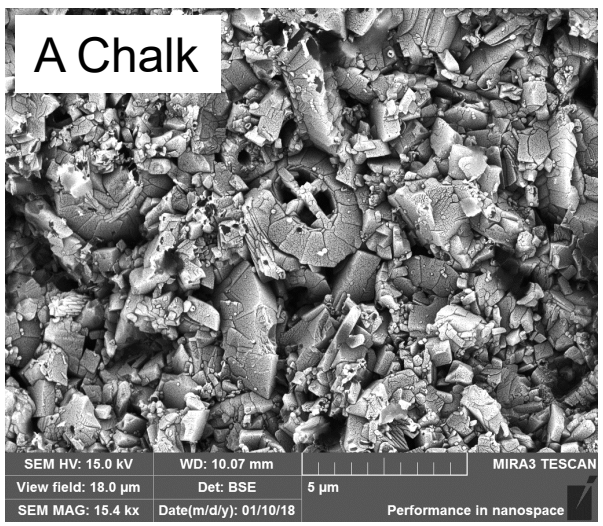
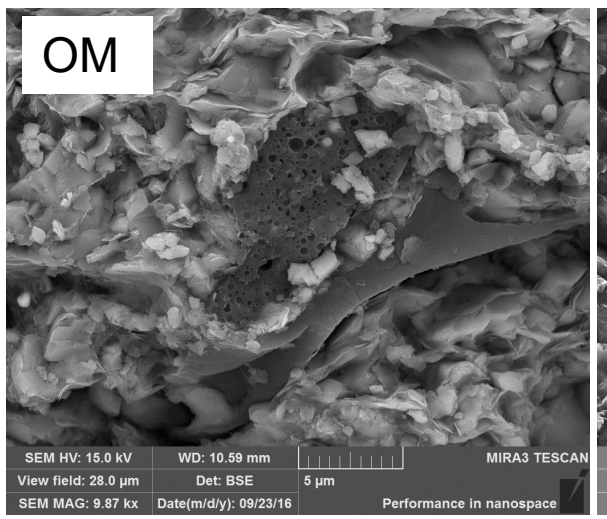
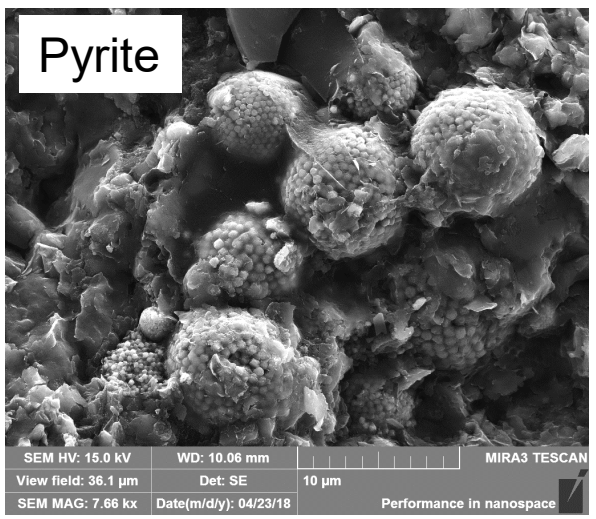
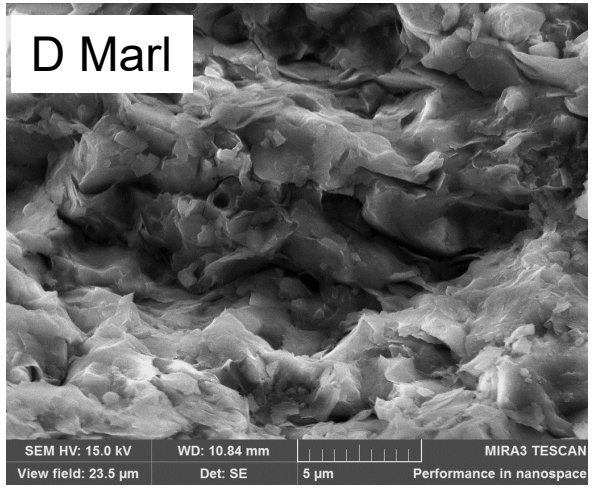
Pore Types

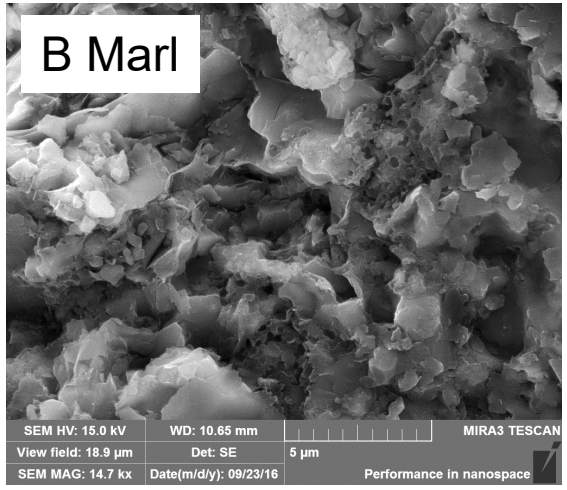

A Chalk
SEM HV: 15.0 kV
WD: 10.02 mm
MIRA3 TESCAN
View field: 88.9 µm
Det: SE
20 µm
SEM MAG: 3.11 kx
Date(m/d/y): 11/12/15
Colorado School of Mines

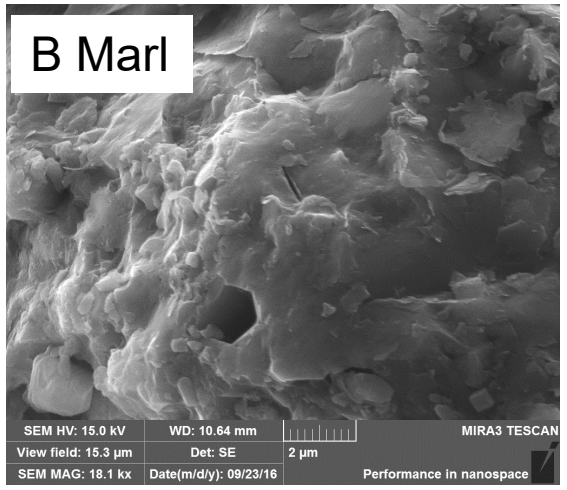

A Chalk
SEM HV: 15.0 kV
WD: 10.07 mm
MIRA3 TESCAN
View field: 18.0 µm
Det: BSE
5 µm
SEM MAG: 15.4 kx
Date(m/d/y): 01/10/18
Performance in nanospace

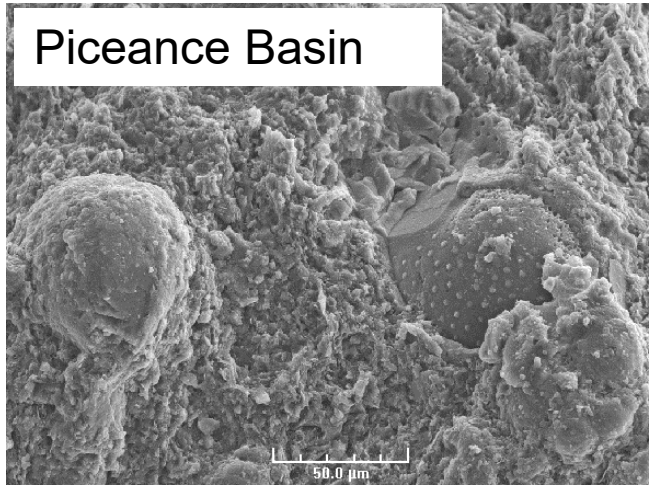

OM
SEM HV: 15.0 kV
WD: 10.59 mm
MIRA3 TESCAN
View field: 28.0 µm
Det: BSE
5 µm
SEM MAG: 9.87 kx
Date(m/d/y): 09/23/16
Performance in nanospace


Pyrite
SEM HV: 15.0 kV
WD: 10.06 mm
MIRA3 TESCAN
View field: 36.1 µm
Det: SE
10 µm
SEM MAG: 7.66 kx
Date(m/d/y): 04/23/18
Performance in nanospace


D Marl
SEM HV: 15.0 kV
WD: 10.84 mm
MIRA3 TESCAN
View field: 23.5 µm
Det: SE
5 µm
Performance in nanospace


B Marl
SEM HV: 15.0 kV
WD: 10.65 mm
MIRA3 TESCAN
View field: 18.9 µm
Det: SE
5 µm
SEM MAG: 14.7 kx
Date(m/d/y): 09/23/16
Performance in nanospace


B Marl
SEM HV: 15.0 kV
WD: 10.64 mm
MIRA3 TESCAN
View field: 15.3 µm
Det: SE
2 µm
SEM MAG: 18.1 kx
Date(m/d/y): 09/23/16
Performance in nanospace


Piceance Basin
50.0 µm